A comparison of fiberoptical guided tracheal intubation via laryngeal mask and laryngeal tube

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ABSTRACT

Background: Fiberoptical assisted intubation via a placed laryngeal mask airway (LMA) has been described as save and easy procedure to manage a difficult airway. The laryngeal tube (LT) is a promising alternative to the LMA as supraglottic airway device. Fiberoptical assisted intubation via LT is possible, however considered more difficult. The aim of this study was to compare the fiberoptical assisted intubation via LT and LMA. **Materials and Methods:** A total of 22 anesthesiologists with different levels of experience participated in the study performed on an adult airway model. Primarily the supraglottic device was placed and correct position was confirmed by successful ventilation. A 5 mm internal diameter tracheal tube was loaded onto a flexible 3.6 mm fiberscope and the so prepared device was inserted into the proximal lumen of the LMA or the LT. The glottis was passed under visual control and the tube advanced into the trachea. After removal of the fiberscope, ventilation was examined clinically by inspection. Success rates, procedure time and observed complications of LMA versus LT were compared (U-test; $P < 0.05$). **Results:** Placement of the endotracheal tube was successful in all attempts using both the LMA and LT. There was no difference in the time needed for the placement procedure (33 [26-38] s LMA; 35 [32-38] s LT). Only minor technical complications were observed in both groups. **Conclusion:** A fiberoptical assisted intubation via LT can be considered as a relevant alternative in advanced airway management.

Key words: *Difficult airway, fiberoptic intubation, laryngeal mask, laryngeal tube*

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INTRODUCTION

Successful airway management is the primary goal during general anesthesia as well as in many emergency situations.

While tracheal intubation is considered the gold standard, it requires adequate skills. There is a reported incidence of difficult intubation ranging from 0.05% to 18%, respectively.[1] The American Society of Anesthesiologists (ASA) Task Force on Management of the Difficult Airway emphasizes the importance of alternative, less invasive devices for adequate oxygenation in case tracheal intubation fails.[2] The laryngeal mask airway (LMA) is explicitly mentioned in the 2003 ASA recommendations. Another supraglottic alternative is the laryngeal tube (LT), which was marketed in 1999.[3] The LT is a single-lumen tube with esophageal and pharyngeal cuffs that are connected to a single inflation line with a ventral opening for ventilation between the two cuffs [Figure 1].[3] After blind insertion, the device provides a patent airway in the majority of patients at the first attempt.[4,5] The LT can be inserted quickly without extensive training and is considered a simple tool for airway management.[3] The esophageal cuff of the LT also provides a good airway seal,[4] which was found to be significantly better than that of the standard LMA.[5] First reports of successful use of the LT in emergency airway management suggest that this device might provide a feasible alternative to the LMA.[6,7] Nevertheless in some emergency situations and various elective procedures (e.g., abdominal surgery and prone positioning), tracheal intubation is still required to protect the patient from aspiration.[3,8]

In case of a failed intubation, adequate oxygenation of the patient can be achieved by inserting a supraglottic airway device. When the replacement of the supraglottic device by a tracheal tube is necessary, maximum patient safety must be

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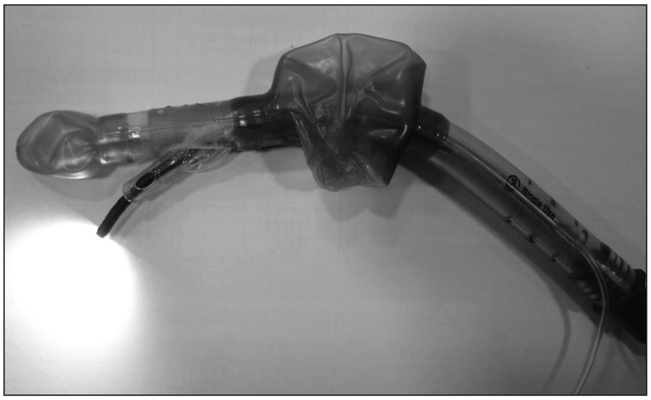

Figure 1: Flexible fiberscope with mounted 5.0 internal diameter tube inserted in the laryngeal tube (#4 LT-D)

considered. However, the primarily inserted device can be considered as dedicated airway; it is dedicated to maintain airway patency while other interventions are prepared or take place.[9] Ideally, oxygen can be provided throughout the tube exchange process to avoid desaturation.

Atherton described a facilitated intubation via LMA using a tube exchanger.[10] A more sophisticated procedure was described by Hawkins *et al*.: To ensure proper placement of the tracheal tube, the tube exchanger is placed under the fiberoptic guidance.[11] A very similar procedure was published by Genzwuerker *et al.* using a LT as primary airway. Again the tube exchanger was placed under fiberoptic guidance and allowed the fast and easy placement of the tracheal tube.[12] In direct response to this study, Cook *et al.* assume that the LT is less suitable as dedicated airway. The direct fiberoptic visualization of the glottis is thought to be more difficult making the intra-tracheal placement of the tube exchanger more complicated.[8]

The aim of this study was to evaluate the fiberoptic intubation via LT and LMA. Success rates, complication rates, and performance time were compared between the two dedicated airways.

Instead of using a tube exchanger, a small endotracheal tube was directly placed through the already inserted supraglottic device. This approach eliminates one step of the airway management procedure. Goal was to facilitate handling, lower the risks of losing airway patency, and avoid a potential aspiration. While the direct placement of a tracheal tube via LMA has been described before, this method has not been described for the LT so far.

MATERIALS AND METHODS

Due to the study design approval of the local Ethics Committee was not required. A total of 22 clinically practicing anesthesiologist with different levels of experience participated in the study. An adult airway management model (Laerdal Airway Management Trainer, AMT) was used throughout the experiment.

A size 4 LT-D (VBM, Sulz am Neckar, Germany) and a size 4 LMA Unique (LMA, Bonn, Germany) were used as supraglottic airway devices.

Laryngeal tube and LMA were inserted following the manufacturer's instructions. Before insertion, cuffs were deflated and a water-soluble lubricant (Instru Gel, Dr. Deppe Laboratorium, Kempen, Germany) was applied to the cuffs. The head of the airway model was extended on the neck ("sniffing position"). The tip of both devices was placed against the hard palate behind the upper incisors and the device was inserted in the center of the mouth until resistance was felt. The cuffs of the LT were inflated using a cuff inflator (VBM, Medizintechnik, Sulz, Germany) with 80 ml of air, while the cuff of the LMA was inflated with 30 ml of air using a standard syringe. Adequate airway control was confirmed by bilateral lung expansion.

Ventilation via the supraglottic device was continued while a 3.4 mm flexible fiberscope (10BS, Pentax, Hamburg, Germany) was mounted with an endotracheal tube (microlaryngeal tracheal tube internal diameter 5.0) (Mallinckrodt Medical, Hennef, Germany), length 33 cm and inner diameter 5.0 mm.

The breathing circuit was disconnected and the prepared device was inserted through the LT or LMA. The fiberscope was pushed forward until the larynx could be visualized. The fiberoptic view was assessed with the tip of the fiberscope in the bowl of the LMA and at the distal ventilation orifice of the LT. The exact position of the supraglottic device in relation to the glottic structures was registered. Therefore, the fiberoptic scoring system introduced by Brimacombe and Berry for the LMA was used. The view was graded from 1 to 4: 1 = vocal cords fully visible; 2 = vocal cords partially visible or arytenoid cartilages visible; 3 = epiglottis visible; 4 = no laryngeal structures visible. Then, the glottis was entered and the bronchoscope with the endotracheal tube was advanced into the trachea [Figure 2]. The flexible fiberscope was removed after the bifurcation was visualized. Correct positioning of the tracheal tube was verified clinically, after the breathing system was attached. Adequate ventilation was assessed by inspection of the lungs and the stomach.

All participants had the chance to practice both methods until they felt secure with the individual technique. About 4 weeks after the training session all participants were asked to perform the facilitated intubation in a random order.

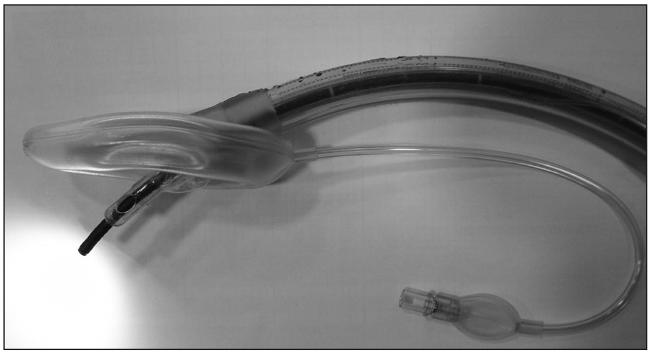

Figure 2: Flexible fiberscope with mounted 5.0 internal diameter tube inserted in the laryngeal mask (#4 LMA Unique)

Different time intervals were defined and recorded. Time for LMA or LT insertion was measured from removal of the face mask to the connection of the breathing system to the supraglottic airway device. A second time interval, measuring the preparation time of the fiberscope was recorded during ventilation via the supraglottic device. A third time interval was measured from disconnection of the LT or LMA until first ventilation via endotracheal tube.

During the intubation process, the visualization of the glottis was documented for every attempt. Finally, successful placement of the tracheal tube was documented. Any difficulties during the procedure were recorded in a standard protocol.

All data are given as mean and interquartile range. Success rates, measured time intervals and glottis visualization scores were compared using the Mann-Whitney-U-test. $P < 0.05$ was considered as statistically significant.

RESULTS

There was no relationship between the level of anesthesia training and the order of the examined methods.

Placement of the supraglottic device took 16 (13-18) s for the LMA and 16 (12-19) s for the LT, respectively and was not different between the two groups [Tables 1 and 2].

Preparation time of the fiberscope was the same for both devices and lasted 34 (28-37) s.

Successful placement of the endotracheal tube was possible in all attempts for both LT and LMA. There was no difference in the time needed for the placement of the tracheal tube (35 [32-38] s LMA and 33 [26-38] s LT).

Glottic view and complication rates were not different between the two groups (1 [1-2] LMA; 1 [1-2] LT).

Table 1: Duration of placement of the supraglottic airway

Order of devices	Experience (years)	Placement of the LMA in seconds	Placement of the LT in seconds
LMA first (*n*=11)	2 (1-5)	14 (13-17)	16 (14-17)
LT first (*n*=11)	2 (1-4)	18 (13-19)	16 (11-21)
Both groups (*n*=22)	2 (1-4)	16 (13-18)	16 (12-19)

Experience of the participants and time needed for placement of the supraglottic device. Data as median and interquartile range. No difference between the two different methods were seen $P < 0.05$; U-test. LMA: Laryngeal mask airway; LT: Laryngeal tube

Table 2: Duration of fiberoptical intubation and glottic view

Order of devices	Experience (years)	Apnoe time LT (s)	Apnoe time LM (s)	Glottic view LT	Glottic view LMA
LM first (*n*=11)	2 (1-5)	31 (26-37)	38 (34-50)	1 (1-2)	2 (1-2)
LT first (*n*=11)	2 (1-4)	33 (29-42)	35 (31-36)	2 (1-2)	1 (1-1)
Both groups (*n*=22)	2 (1-4)	33 (26-38)	35 (33-38)	1 (1-2)	1 (1-2)

Fiberoptical intubation via LM and LT. Apnea time (disconnection of the supraglottic airway till first ventilation via placed endotracheal tube) Grading of the glottic view: 1: Vocal cords fully visible; 2: Vocal cords partially visible or arytenoid cartilages visible; 3: Epiglottis visible; 4: No laryngeal structures visible. Data as median and interquartile range. No difference between the two different methods were seen $P < 0.05$; U-test. LM: Laryngeal mask; LT: Laryngeal tube; LMA: Laryngeal mask airway

In only two cases, one in each group, lubricant hampered the fiberoptic view. In both cases successful placement was possible after the lubricant was removed.

DISCUSSION

Adverse respiratory events are a common complication in anaesthetized patients, potentially resulting in neurological damage and death.[1] Worldwide approximately 600 people die from difficulties with intubation every year.[1] The incidence of difficult intubation for elective surgery ranges from 0.05% to 18%, according to the type of surgery and the preexisting medical conditions.[1]

These and other results led to the 1993 ASA recommendations for the use of alternative airway adjuncts that allow adequate ventilation and oxygenation of the patients.[13] The LMA was primarily mentioned in the published guidelines in 2003.[2] Since then various other supraglottic airway devices have been brought on the market.

In emergency situations and various other circumstances (abdominal surgery, surgery in a prone position) all of these devices however only serve as bridge to tracheal intubation. Various approaches have been described to establish a definite endotracheal airway using a supraglottic bridge as aid. In these circumstances it is of utmost importance not to jeopardize the already established airway. Therefore, the supraglottic airway can serve as dedicated airway. Adequate oxygenation should continue, while other airway interventions are prepared or take place.

The blind insertion of a tube or exchange catheter has been described previously. Studies have shown that a blind insertion does not necessarily lead to an intratracheal position and that the position of the LMA during fiberoptic control was only central in 59% of all cases.[14] This supports the idea of using a fiberscope rather than inserting a device blindly through any airway device. Due to the variable position of the blindly inserted LMA with respect to the glottic aperture, the use of a fiberoptic bronchoscope increases the success rate of tracheal intubation.[14,15] The fiberoptic assisted intubation via LMA has been evaluated and is considered a reliable and save method to manage a difficult airway. Therefore, the LMA is considered a dedicated airway [Figure 3].

The LT however is a suitable airway management device with a high rate of successful insertion.[3] As placement is considered easy, its acceptance among physicians and paramedics is high.[3,7] Ventilation using the LT is comparable to that with other devices.[5] Providing a good airway seal, the LT has been shown to be efficacious during mechanical ventilation in adult and pediatric patients undergoing elective surgery.[4,16,17] Especially in the prehospital setting the LT is gaining popularity, because of its easy use. Similar to the LMA a fiberoptic assisted intubation technique has already been described with the LT.

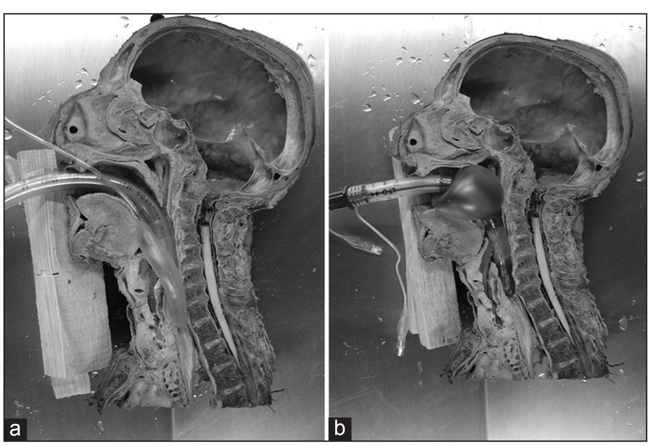

Figure 3: Sagittal view of the head with the endotracheal tube placed over a laryngeal mask (a) and a laryngeal tube (b). → Endotracheal tube entering the glottis

Cook *et al*. however considered the fiberoptical intubation via LT more difficult, because visualization of the glottis is supposed to be worse. This questions the role of the LT as dedicated airway.

The results of this study however demonstrate that the LT can serve as such dedicated airway [Figure 3]. Similar to the LMA it is an important tool to allow sufficient oxygenation and second it serves as guide for positioning the tracheal tube. The time needed for inserting the tracheal tube was comparable to that achieved with the LMA in this and prior studies.[11] The specific configuration of the aperture of the LT guides the tip of the flexible fiberscope towards the glottis. The glottic aperture could be visualized in all attempts with minimal manipulation of the LT. However, for safety reasons a blind insertion of the tracheal tube without fiberoptic control cannot be recommended. Only fiberoptic control of the tube position guarantees a maximum degree of patient safety.

Our data clearly show that using the LT as well as the LMA provides an excellent fiberoptic view of the glottis enabling the introduction of a tracheal tube. In fact, the time required for placement of the endotracheal tube through the device is low.

These results are encouraging, especially because oxygen administration remains possible at various steps of the maneuver. Oxygenation can continue during endoscopy either using a bronchoscopy adapter or via the suction channel of the endoscope. The dedicated airway will not only help to master unexpected difficult intubations but also allow training in fiberoptic intubation, even in patients known to be difficult to intubate under safe conditions.[9] Only minor complications occurred. Lubricant hampering the view through the optical device can easily be removed allowing appropriate conditions.

This study involved anesthesiologists with different levels of experience. Some of the participants even had no prior experience using a flexible bronchoscope or the LT. The fact that the level of anesthesia training did not correlate with success of the procedure or the required time indicates the feasibility of the two techniques. Apparently both interventions are easy to learn. A follow-up study at a different time point could give information about retention of knowledge.

The direct placement of an endotracheal tube via a supraglottic bridge has various advantages compared to the initial placement of a tube exchange catheter. Mucosal lesions in the trachea have been described and are related to the rigid tip of the tube exchange catheter, which has to be held in place during removal of the supraglottic device. Furthermore only an endotracheal tube can prevent aspiration. Yet the size of the introduced tube is limited by the inner diameter of the supraglottic airway.

However, there are limitations of this study. The used airway model does not simulate a difficult airway. The feasibility of this technique has to be evaluated under adequate conditions. Finally, this study would have to be repeated with patients to monitor hemodynamic parameters and changes in peripheral oxygen saturation.

CONCLUSION

Both, the LMA and the LT can serve as emergency airways to allow oxygenation in case of difficult intubation. There is no difference in success rate and performance time in a fiberoptic facilitated intubation using both devices as guidance. Both supraglottic bridges can therefore serve as valuable tools in advanced airway management resembling dedicated airways.

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